Four marinas are located near Bogue Inlet and include, Dudley's Marina, Casper's Marina, and the Nancy Lee Fishing Center on NC Highway 24 near Swansboro, NC and the Island Harbor Marina located in Emerald Isle. All four have boat slips, and overnight dockage and all but Casper's Marina offer charters for deep sea fishing and sight seeing. Bogue Inlet Pier is a favorite fishing and beach resort destination for thousands of visitors each year. Located on the west end of Emerald Isle, close to Bogue Inlet, the pier is used to catch many different species of sport and recreational fish such as, Black Drum, King Mackerel, Flounder, Spotted Sea Trout, and Spot fish. The beaches of Emerald Isle provide a variety of excellent scenic and recreational opportunities for the public. Popular activities include, but are not limited to, surf fishing, swimming, walking, shell hunting, sunbathing, bird watching, kayaking and boating. Scenic vistas of the ocean are many. Surfing is especially high in the area. Emerald Isle is known for its great wave activity. However, with erosion of the beach there have been significant losses of dry beach areas limiting many beach activities to low tide periods.

4.13 NAVIGATION

Bogue Inlet serves as the access point for several recreational and fishing vessels year- round. During the year, especially during peak tourist season, the Inlet can experience intense recreation navigation usage. Federally

authorized and maintained channels in the vicinity of Bogue Inlet include: the Atlantic Intracoastal Waterway (AIWW) which has an authorized depth of 12 feet MLW and a bottom width of 90 feet; a 12-foot deep by 90-foot wide side channel leading from the AIWW through the lower portion of the White Oak River to the Town of Swansboro; a 6-foot by 90-foot wide channel from the AIWW to the gorge in Bogue Inlet; and an 8-foot by 150 wide channel from the gorge in Bogue Inlet to the Atlantic Ocean.

A few commercial vessels (45 to 50 feet in length) and many recreational boats (16 to 35 feet in length) utilize the inlet (Cone, Coast Guard Auxiliary, Swansboro, pers. comm.). Mr. Lee Manning, of the Nancy Lee Fishing Center has noted that there are few fishing boats use the Inlet during the winter (Manning, pers. comm., 2003). Diving in the area is year round and includes trips to the several shipwrecks offshore. Bogue Inlet's navigational usage also includes military exercises. The Marine Corps has used Bogue Inlet in the past for simulated attacks on Camp Lejeune, located in south Onslow County (Cone, pers. comm., 2003). Therefore, Bogue Inlet is highly used for a variety of navigational uses, throughout the year.

4.14 HISTORIC PROPERTIES AND CULTURAL RESOURCES

Humans have inhabited the area surrounding Bogue Inlet for over 2,500 years. However, the area remained largely unsettled until the 1950's. The area was originally home to the Algonquin Indian tribe, a nomadic tribe of Native Americans, from 500 A.D. to about colonial times. The Europeans the Native Americans from the area after the Tuscarora War in 1711, in which the Algonquin and Tuscarora Indian tribes attacked New Bern and the surrounding countryside (Swansboro Historical Association, 1990).

Around 1730, the first permanent settlement was established on a former site of an Algonquin Indian Village, at the mouth of the White Oak River. They called this settlement Swansborough (Swansboro) after Samuel Swan, former Speaker of North Carolina's House of Commons. In 1771 Theophilus Weeks became the "founder of Swansboro" which remained the only permanent settlement on the coast between Wilmington and Beaufort for several years (Littleton, 1983). The early colonial economy of Onslow County was based primarily on small-scale agriculture, fishing and on forest products (Louis Berger Group, 2002). The lack of adequate roads in this region led Bogue and Bear Inlet to become principal trading areas (Angley, 1984).

Throughout the 1700's, the area was well–known as pirate territory. The famous pirate, Blackbeard supposedly used the inlets along the coasts and the shallow waterways behind the barrier island as safe havens. It was

thought that Bear Island, west of Bogue Inlet, was used by Blackbeard as a get–away while he terrorized traders. Many of the shipwrecks off the coasts of North Carolina may be due to Blackbeard. In fact, it is believed that one shipwreck, directly off the coast from Beaufort Inlet, could be Blackbeard's pirate ship, *Queen Anne's Revenge*, which sunk around 1718. The general Cape Lookout area, which includes ocean waters stretching from Drum Inlet around the cape to Bogue Inlet, contains at least 184 historically documented shipwrecks.

During times of war, the Inlet played various important roles. Throughout the Revolutionary War, a number of patriot privateers operated through the Inlet preying on English merchant ships. Salt works were created in the Swansboro area because the British blockade prevented imports. Following America's independence Swansboro began its transformation into a coastal port. In 1786, Swansboro took over customs functions in the region (Watson, 1995). The major exports from Swansboro and Deer Island consisted of tar and turpentine. These resources were heavily exported from 1770 until the late 19th century.

The War of 1812 and the British Navy blockage of the American coast led to a slowdown in the trading industry and construction of ships. The construction of ships resumed when the war ended and agricultural products became increasingly important as a commodity of trade. Maritime trade reached its peak in Swansboro shortly before the onset of the Civil War.

Huggin's Island was the site of a fort built by the Confederates to guard Bogue Inlet and the major access channel to Swansboro during the Civil War. The fort was burned and Swansboro was captured twice between 1862 and 1864 by the Union forces. Salt works were established once again on Deer Island. However, they were destroyed in 1862 by a Union raid. Trade and commerce in Swansboro had suffered great losses by the end of the war (Wilmington Journal, 1862). The years after 1865 showed a slow recovery of the town's exports but the shipbuilding industry never fully recovered. Inlets, especially Bogue Inlet, tended to silt up during this time without dredging. Lumber and fishing became the center of Swansboro's economic base. Construction on the Intracoastal Waterway began in the 1920's. Its construction brought an increase to the number of commercial vessels in the area.

During World War II, the U.S. Coast Guard used Bear Island to secure the coast and monitor German U–boat activity. At this time trawl fishing and trawler construction became important in the area (Still, 1983). After the war ended, the Marine Corps base was established in Jacksonville. The

economic contributions moved to involve more civil service employment, tourism and retirement community development.

The National Historic Preservation Act of 1966 and the Archeological and Historic Act of 1979 established criteria for identification, documentation, and assessment of submerged cultural resources. Compliance with submerged cultural resource legislation is administered by the North Carolina Division of Archives and History and the US Department of the Interior. These archives and governmental agencies give no mention of any shipwrecks in or near Bogue Inlet.

In January and June 2003, Tidewater Atlantic Research, Inc., of Washington, N.C. (TAR), conducted a magnetometer survey of the central portion of the Bogue Inlet ebb tide delta and the existing channel to determine the presence of potentially significant submerged cultural resources. Three anomalies were found, two on the ebb tide delta and a third in the existing channel at a point approximately 1,600 feet north of Inlet Drive. The two anomalies found on the ebb tide delta were relatively small and appeared to be consistent with modern debris such as small diameter pipes, boat anchors, or crab traps and therefore were considered to be of no archeological significance. The anomaly found in the existing channel exhibited characteristics consistent with submerged cultural resources. Since alternatives that would include modifications of Bogue Inlet would only involve filling of the existing channel, TAR concluded that no further investigation were warranted.

4.15 SOCIO-ECONOMIC

The Crystal Coast includes the coastal shoreline of Atlantic Beach, Emerald Isle, Indian Beach, Salter Path and Pine Knoll Shores. These towns, specifically Emerald Isle, have shown exceptionally high population growth rates in the last decade. Based on the growth rate from 1990 to 1995, Emerald Isle was ranked 17th out of the 117 municipalities in the state, with population increases from 2,500 to 9,999. From 1990 to 2000, the population of Emerald Isle increased 43.3% from 2,434 to 3,488. The adjacent town of Swansboro also showed a significant population increase of 22.4% from 1,165 to 1,426 from 1990 to 2000 (North Carolina State Demographics, 2003).

Carteret County is a primary vacation destination for many domestic and international visitors. Carteret County relies on the tourism industry as its primary source of revenue. Restaurants, motel accommodations, recreational fishing, retail trade services, construction, real estate, and finance industries benefit directly from the impact of tourism. (NCDCM,

1996) Many visitors utilize the beaches of Emerald Isle, which accounts for a large portion of the revenue generated in the area (NCDCM, 1996). Surfing, waterskiing, jet skiing, and wind surfing are a few of the recreational activities available to visitors of Bogue Inlet. However, in many places, high erosion rates can limit beach use to low tide events. Beach renourishment is expected to attract more visitors and contribute favorably to the local economy, resulting in increased revenue.

The permanent population of Emerald Isle has grown steadily since 1991 increasing from slightly over 2,400 in 1991 to approximately 3,500 in 2002. During the summer tourist season, the population swells to over 50,000. Accordingly, the town must structure is services to support the inflated seasonal population.

The economy of Emerald Isle depends on tourism and support of a growing population of retirees. Businesses focus on providing the necessary services to support the seasonal visitors and year-round residents. There are numerous restaurants, retail stores, and motels all of which are located in a compact business district along the west end of Emerald Drive. There are also businesses that provide or support recreational opportunities such as fishing, surf boarding, boating, and other water oriented activities.

Since the late 1970's, Carteret County has been the number one ranking county in the state in terms of total licensed commercial fishing vessels, total seafood landings (pounds), and total dockside value of seafood landings (NCDCM, 1996). Shellfishing is an important economic resource for the White Oak River. The North Carolina Administrative Code (15A NCAC 02B) states that Class SA waters, which includes Bogue Inlet, identifies shellfishing for 'market purposes' as its best usage of waters (NCDENR, 2002). The outstanding quality of the water allows for abundant shellfishing in the area. The White Oak River shellfish resources are considered productive, but threats to the health of the shellfish do exist. Shellfish closures that occur in the area are typically due to an increase in sedimentation and stormwater runoff.

The 2001-2002 tax base for all of Emerald Isle was over $1.33 billion or almost double the value of the 1992 tax base. The tax rate is a modest $0.175 per $100 valuation and funds the majority of the Towns budget which was almost $5.4 million in 2001-2002.

4.16 LAND USE

The Coastal Area Management Act (CAMA) requires counties, cities and towns within the 20 coastal counties, to periodically prepare land use plans

to protect and manage the health of the coastal environment and economy. CAMA Areas of Environmental Concern are classified as conservation and include all areas within both the Permit and Project Areas. Land use community decisions are based on the seasonal or peak population months. Land use plans developed by both Carteret and Onslow Counties are intended to be an integral and sensible part of North Carolina environmental law.

The North Carolina Division of Coastal Management requires that the 20 coastal counties keep the Land Use plans updated. The Onslow County Joint Land Use Study was recently updated in February 2003. The Carteret County Land Use Plan was last updated in 1996, but is currently being revised for anticipated release in May 2004. (M. Christenberry, pers. comm. 2003).

The Town of Emerald Isle occupies approximately 5.6 square miles on the west end of Bogue Banks with most of the land used for single family and multi-family housing. Very few buildings in the town are over three stories. Businesses are located in a compact area along the west end of Emerald Drive and include restaurants, motels, and traditional retail stores. Emerald Isle strives to maintain its small town family oriented atmosphere that supports both its year-round residents and seasonal visitors. Private property owners and developers alike make a conscious effort to preserve native vegetation and as a result, the landscape of Emerald Isle is dominated by native trees and shrubs.

Retirement and tourism are the focus of the local economy with the major employers associated with the retail and service sector. The town boasts a healthy beach system and is committed to its enhancement and maintenance. In this regard, the Town of Emerald Isle pass a bond referendum to fund a beach nourishment project that will eventually restore 9.7 miles of it's nearly 11 mile ocean beach. To date, the town has completed construction of 5.9 miles of the beach nourishment project with the completion of the remaining 3.8 miles scheduled for the fall of 2004.

Recreational opportunities abound in Emerald Isle with the focus being on water oriented activities including swimming, sunbathing, and fishing to mention a few. The Town has one fishing pier, the Bogue Inlet Pier, located in the heart of the business area.

Emerald Isle protects its coastal lifestyle by giving preservation of natural resources and protection of water quality the highest priority. The Town cooperates with state and federal agencies to protect coastal wetlands from harmful development. Important freshwater wetlands are intact and they continue to store, clean water, and provide a rich habitat for a rich diversity of plants and animals. The Town protects surface waters from degradation by storm water and polluting discharges and they remain clean.

4.17 HYDRODYNAMICS

4.17.1 Tides and Tidal Flow

The mean tide range in the Atlantic Ocean in the vicinity of Bogue Inlet is 3.7 feet while the average spring range is 4.3 feet. The primary tidal datum is the National Geodetic Vertical Datum-1929 (NGVD). The relationship between NGVD and other tidal datum are as follows:

Mean Higher High Water (MHHW)..... +2.53 feet NGVD
Mean High Water (MHW)..... +2.21 feet NGVD
Mean Tide Level (MTL)..... +0.35 feet NGVD
NGVD.....0.00 feet NGVD
Mean Low Water (MLW).....-1.50 feet NGVD
Mean Lower Low Water (MLLW).....-1.75 feet NGVD

The mean tide range for Bogue Inlet, which was determined at the US Coast Guard Station, is 2.2 feet with a mean spring range of 2.6 feet. On the average, the time of high tide and low tide at the Coast Guard Station lags the ocean tide by 28 minutes and 26 minutes respectively.

The tidal prism of Bogue Inlet, i.e., the total volume of water flowing through the inlet during an ebbing tide or flooding tide, was determined from flow measurements made by Coastal Science and Engineering, PLLC (CSE) on 16 October 2001 during a period of spring tides. Based on these flow measurements, the ebb tidal prism was 7.66×10^8 cubic feet while the flood tidal prism was 5.57×10^8 cubic feet.

O'Brien (1969) discovered a strong relationship between the cross-sectional area of an inlet (measured at mean sea level) and its spring tidal prism. This relationship comes about as a result of the natural balancing of tidal flow forces that tend to scour the inlet and littoral transport that deposits sediment in the inlet. Jarrett (1976) developed refinements in the functional relationship between an inlet's cross-sectional area and its tidal prism by considering inlets on the Atlantic, Gulf, and West Coast of the U.S. as well as whether the inlets were stabilized with one jetty, two jetties, or not

stabilized by structures. For inlets on the Atlantic Coast of the U.S., this relationship is given by:

$$A = 5.37 \times 10^{-6} P^{1.07} \text{ (Jarrett 1976)}$$

Where: A = Minimum cross-sectional area in square feet
P = Spring tidal prism in cubic feet

The minimum cross-sectional area of Bogue Inlet obtained from the October 2001 survey by CSE was 13,600 square feet. The cross-sectional area predicted by the above equation for the average tidal prism of Bogue Inlet (i.e., the average of the flood and ebb tidal prisms) is 14,700 square feet. The agreement between the measured and predicted inlet cross-sectional areas is rather good considering inlets are know to undergo short-term fluctuations in their cross-sectional area of the order of ±10% due to high sediment loads during storms or as a result of changing lunar or meteorological tide conditions. The agreement between the measured and predicted minimum cross-sectional area indicates that Bogue Inlet maintains a balance between the hydraulic forces tending to keep it open (tidal flow) and sedimentary forces (littoral transport) that would tend to close it.

The hydrodynamics of Bogue Inlet were evaluated using the Advanced Three-Dimensional Circulation Model for Shelves, Coasts, and Estuaries (ADCIRC). The model was constructed from a detailed hydrographic and topographic survey of the inlet obtained by CSE in September and October 2001 with supplemental soundings from the Corps of Engineers and National Ocean Service navigation charts. The model was calibrated and verified with tide and current data also obtained by CSE in September and October 2001. Details of the numerical model investigation are provided in Appendix B.

For the base or existing conditions in Bogue Inlet, the existing bar channel carries 71.6% of the inlet's ebb tidal prism while 22.7% flows across the middle portion of the ebb tide delta. The remaining 5.7% of the ebb tidal prism flows past the east end of Bear Island. During flood, the existing channel and the middle portion of the ebb tide delta carry equal portions of the flood tidal prism (46.5% each) with the balance flowing past the east end of Bear Island. Eastern Channel serves as the main channel connecting the inlet to the AIWW and Bogue Sound during both ebb and flood while the Western Channel only carries approximately 9% of the ebb and 20% of the flood tidal prism.

4.17.2 Waves

Wave information for the Bogue Inlet area was obtained from the Wave Information Study (WIS) conducted by the U.S. Army Corps of Engineers

Engineering Research and Development Center, Coastal Hydraulics Laboratory located in Vicksburg, Mississippi. The WIS wave information is based on a 20-year hindcast (1976 to 1995 inclusive) of wave conditions based on synoptic wind patterns over the entire Atlantic Ocean basin and includes the effects of hurricanes and other tropical storms. The wave information is provided in 3-hour increments for the entire 20-year period. The WIS station used is designated as AU2045 and is located in 90 feet of water off the west end of Emerald Isle (see Figure 5.13 in Appendix B (Engineering, Geology, and Geotechnical Investigations).

The general alignment of the shoreline in the vicinity of Bogue Inlet is North 70 degrees East; therefore, waves propagating from the north-northeast clockwise around to the west-southwest are moving onshore. Table 10 provides a summary of the energy distribution by wave angle.

Based on the percent of wave energy moving in the onshore direction, 60% of the wave energy would tend to move sediment in a westerly direction and 40% of the wave energy would move sediment in an easterly direction.